PREPARATION OF ENZYMATICALLY ACTIVE SPONGES OR FOAMS FOR DETOXIFICATION OF HAZARDOUS COMPOUNDS

RELATED APPLICATIONS

This application is based on Provisional Application No. 60/130,987, filed Apr. 26, 1999.

TECHNICAL FIELD

This invention relates to materials, compositions, kits and methods for neutralizing, detoxifying or decontaminating equipment and/or personnel exposed to organophosphorous and organosulfur compounds.

BACKGROUND OF THE INVENTION

Methods for decontamination, neutralization and removal of chemicals, such as organophosphorous and organosulfur (OP refers to both) compounds, herbicides and insecticides, are known in the art. However, the compositions and devices utilized in the prior art methods have undesirable properties, such as corrosiveness, flammability, toxicity, difficulty in making and storing, and limited shelf-life.

For example, DS2, a standard decontamination agent, comprises 70% diethylenetriamine, 28% ethylene glycol monomethyl ether, and 2% NaOH by weight. Although DS2 is effective, it is corrosive upon exposure to air. DS2 and any matter resulting from its use is classified and regulated as hazardous material. After an application, the DS2 must stand for 30 minutes before rinsing the treated area with water. Additionally, DS2 comprises a teratogen.

Some decontamination methods employ hypochlorite formulations which are corrosive and toxic and injure humans and sensitive tissues such as eyes. Other methods comprise incinerating the contaminated material and utilizing carbon filters to absorb the residual chemicals. Yet other methods utilize polymer beads or microemulsions which absorb the chemical and must be rinsed away. These methods are inherently dangerous, expensive and generate hazardous waste. Furthermore, as many of these compositions and compounds utilized degrade upon exposure to water and carbon dioxide, these compositions and compounds must be used the same day they are made.

Some in vivo methods employ cholinesterases in the presence of nucleophilic oximes to detoxify OP compounds. This enzyme bioscavenger approach is effective against a variety of OP compounds in rodents and nonhuman primates. For examples pretreatment of rhesus monkeys with fetal bovine serum acetylcholinesterase (FBS-AChE) or horse serum butyrylcholinesterase (Eq-BChE) confers protection against up to 5 LD_{50} of soman, a highly toxic OP nerve agent. Although, the use of an enzyme as a single pretreatment drug for OP toxicity is sufficient to provide complete protection to an individual subject, a relatively large (stoichiometric) amount of the enzyme is required to neutralize the OP compound in vivo. Therefore, OP/enzyme stoichiometry is increased by combining enzyme pretreatment with oxime reactivation so that the catalytic activity of OP inhibited FBS-AChE is rapidly and continuously restored, and the OP compound is detoxified.

Clearly, a need for better methods and devices for neutralizing, detoxifying, decontaminating and cleaning materials, equipment and personnel exposed to OP compounds exists.

Recently, OP detoxifyng compounds, devices and methods thereof, which allow the safe, effective and convenient detoxification of highly toxic compounds not possible by the prior art, have been developed. These environmentally friendly compounds, devices and methods are disclosed hereinbelow.

SUMMARY OF THE INVENTION

The present invention provides materials, compositions, kits and methods for neutralizing, detoxifying or decontaminating equipment and/or personnel exposed to OP compounds.

In one embodiment, the invention relates to a material comprising a mixture of enzymes and substrates for the removal, decontamination and neutralization of OP compounds including those directed against humans. The mixture of enzymes utilized comprises cholinesterases (ChEs) and/or OP hydrolases and reactivators, such as oximes which includes mono-disquarternary oximes. The material may comprise a flexible or rigid porous support. The porous support may be a polyurethane matrix or equivalent.

For example, the porous support may be a flexible sponge-like substance or like material, wherein the enzymes are secured by immobilization. Depending on the polyurethane prepolymer or substrate utilized, porous supports of varying degrees of flexibility and porosity may be obtained. The porous support may be formed into various shapes, sizes and densities, depending on need and the shape of the mold. For example, the porous support may be formed into a typical household sponge or a towelette. The preferred dimensions of the sponge are 1"×2"×8" to 2"×4"×8". The preferred dimensions of the towelette are 4"×4"×0.25" to 4"×4"×0.03125" to 14"×14"×0.0625". However, during large-scale synthesis, the dimensions of the initial immobilized enzyme product might be large. For example, approximately 4 feet by 8 feet rolls could be produced and sized as appropriate and described above. The sponge-like support would be preferable for use on surfaces, including natural, synthetic and biological surfaces such as equipment, laboratory hardware, devices, skin and other delicate membranes, where decontamination of a rough or irregular surface is desired or where the prior art decontamination materials are incompatible with human tissue. For example, the materials may be used to clean and decontaminate wounds as it is non-toxic and the immobilized enzymes will not leach into a wound. Therefore, the sponges could be used to decontaminate civilians contaminated by a terrorist attack at a public event.

If an object and/or area to be neutralized or decontaminated comprises cracks, crevices, porous or uneven surfaces, a foam-like support is suitable. Application of small quantities may be done with a spray-bottle or spray can with an appropriate nozzle. Further, foam may be selected so that it can be dispensed into the opening of sensitive equipment or an orifice of a subject, such as the ear canal. If a large area is contaminated, an apparatus that dispenses a large quantity of foam may be utilized.

The foam-like support may dissipate after a period of time like shaving cream or it may cure into a stable and flexible sponge-like support. The dissipating foam may be applied on living subjects. The foam, which cures, may be applied around an object and contain the contamination within the foam. Once the foam cures, the object may be handled and moved without further exposure to the hazardous chemical.

When necessary, the material may also comprise a rigid and porous support. The rigid material can be ground into a powder and added to lotions, soaps and other liquids for application. Likewise, the flexible material, supra, may be